

Increasing Driving Safety : Perception & Assessment of Collision Risks with other Road Users

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Increasing Driving Safety

Perception & Assessment of Collision Risks with other Road Users

Dr. Christian LAUGIER

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Invited Talk

Workshop “Safety of Autonomous Vehicles”

Final Scientific event of the French Tornado R&D project

Paris, On-line event, November 5th 2020

Increase Driving Safety

Perception & Assessment of Collision Risks with other Road Users

C. Laugier, Research Director at Inria

Workshop « Safety of Autonomous Vehicles », Tornado project, Nov 5th 2020

- Technological breakthrough & Numerous AV experimentations in real traffic conditions



- Millions of miles driven last decade... but SAFETY is still not fully guaranteed !
=> *Several benign or fatal accidents involving AVs (Perception failure & Takeover difficult)*



=> Perception & Decision-making technologies have still to be improved for mixed traffic !!!

Perception & Situation Awareness Challenges



AI based Perception & Decision-making

Situation Awareness & Decision-making

=> *Safe intentional navigation (using semantics)*



Risk detection & Reflexive Actions

Dealing with unexpected events

=> *Avoiding upcoming collisions with “something”*

Main difficulties

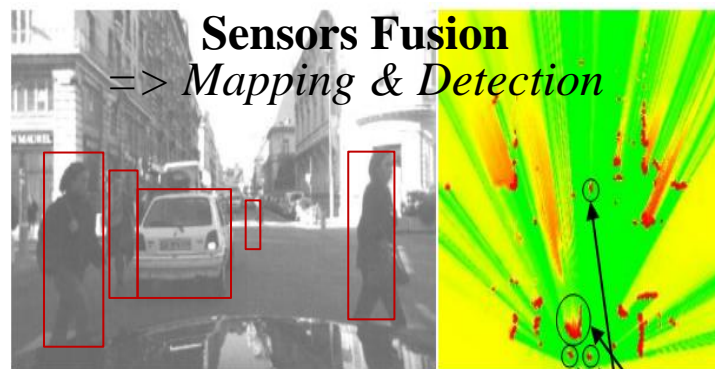
- ❑ Dynamic & Open Environments, Incompleteness & Uncertainty, Sensors limitations, Real-time + Validation
- ❑ Mixed traffic (Human in the loop) => **Human Aware Decision-making process**

Taking into account Interactions + Behaviors + Social & Traffic rules

1st Paradigm: Embedded Bayesian Perception



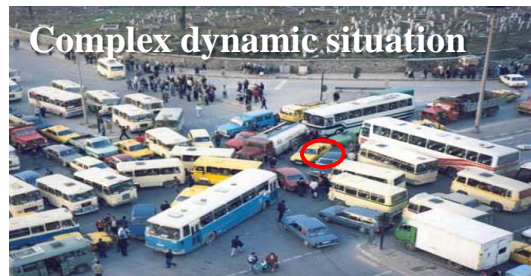
Embedded Multi-Sensors Perception
⇒ *Continuous monitoring of the dynamic environment*



- ✓ *Exploiting the Dynamic information for a better understanding of the scene !!!!*
- ✓ *Reasoning about Uncertainty & Time window ⇒ Past & Future predicted events*
- ✓ *Bayesian Sensors Fusion + Scene interpretation using Contextual & Semantic information*

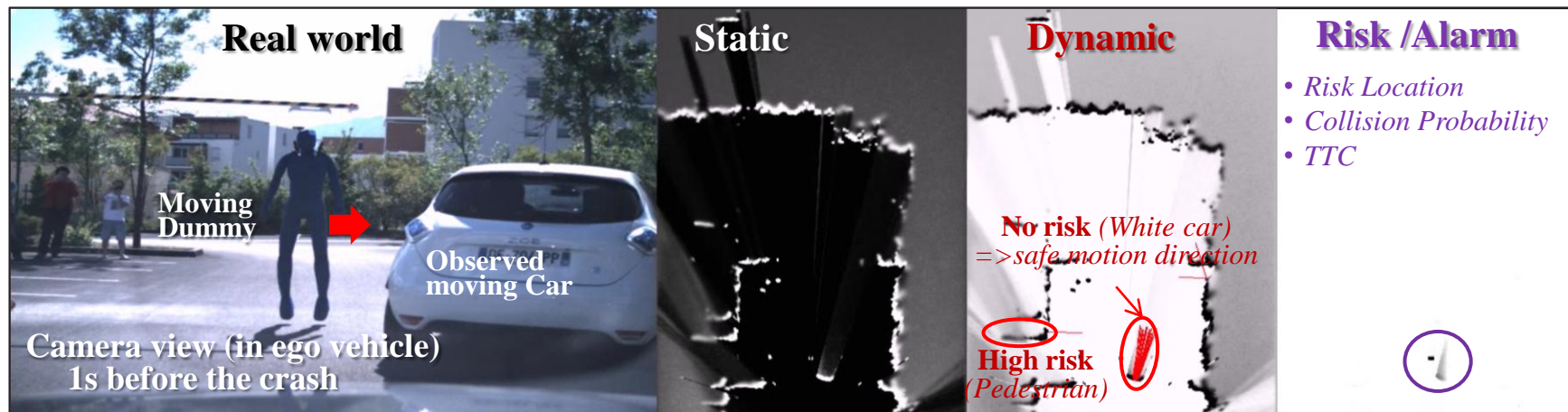
2nd Paradigm: Collision Risk Assessment

=> Avoiding Pending & Future Collisions



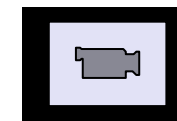
Several
PhD theses

- ✓ Predict environment changes on a given “time horizon $t+\delta$ ” => Using **History & Motion models**
- ✓ Estimate the Probabilistic Risk of Collision at $t+\delta$ (δ = a few seconds ahead)
- ✓ Make Driving Decisions by taking into account the **Predicted behavior** of all surrounding traffic participants (cars, cycles, pedestrians...) & **Social / Traffic rules** (traffic participants interactions)



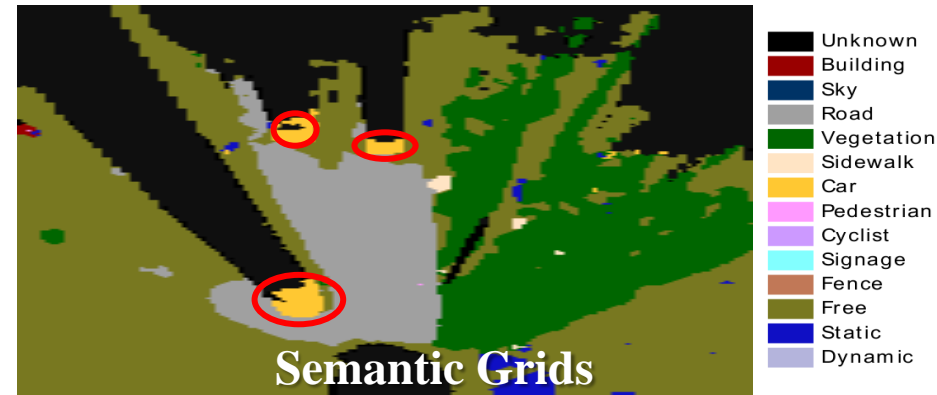
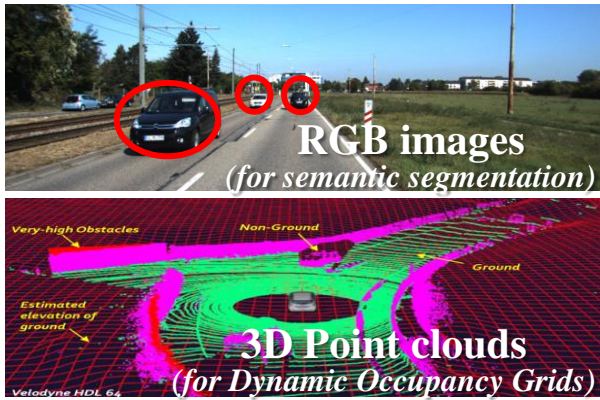
Video: Collision Risk Assessment

- Yellow => time to collision: 3s
- Orange => time to collision: 2s
- Red => time to collision: 1s

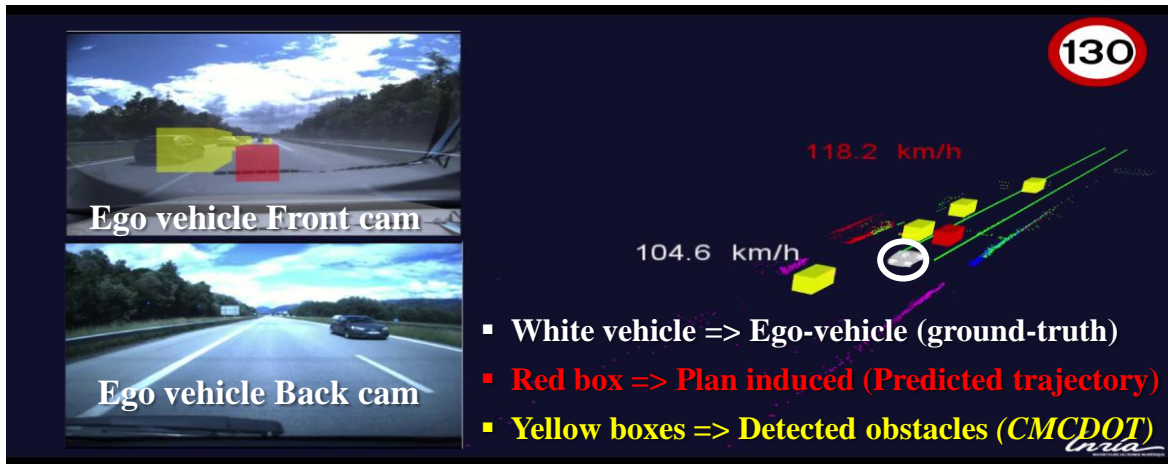


3rd Paradigm: Models improvements using Machine Learning

- Perception level: *Construct “Semantic Grids” using Bayesian Perception & DL*



- Prediction & Decision-making level: *Learn driving skills for Autonomous Driving*



- 1st Step: Modeling Driver Behaviors using IRL
- 2nd Step:
 - Predict behaviors of surrounding vehicles (using Perception & learned Behavior models)
 - Make “safe & consistent” Driving Decisions for Ego Vehicle

- Open questions: *Training step (Available Datasets limited), Real-time processing (difficult), Classification Errors (often not explainable), Domain adaptation (e.g. changing weather conditions)*

Concluding remarks & Discussion

- ❑ Increasing impact of AI + Real-time data processing capacity + Increased sensor performance + New Models & Embedded algorithms + Multiplication of tests in real conditions
 - => *The unmanned car is gradually becoming a technological reality*
- ❑ Safety is not yet fully guaranteed !
 - *Current **Perception & Scene Understanding** algorithms are **not robust enough** for complex & highly dynamic environments*
 - *Need to take better account of **Interactions with other road users** (using also AI approaches)*
 - *Need to develop **Validation & Certification Tools and Methodologies** => Realistic simulators, Real-world testing protocols, Formal methods (e.g. Enable-S3 EU project & future French project Prissma)*
- ❑ User confidence & Acceptance by the human society will be decisive to allow a real deployment (e.g. “cohabitation” with other users such as pedestrians, bicycles, scooters ...)
 - *Autonomous vehicles **a priori safer** than cars driven by humans (inattention).... but **0 tolerance in the event of a fatal accident involving an autonomous vehicle** !*
 - ***Ethics & Responsibility issues** must also be taking into account before any deployment*